

Changes in time of sowing, flowering and maturity of cereals in Europe under climate change

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Abstract:

The phenological development of cereal crops from emergence through flowering to maturity is largely controlled by temperature, but also affected by day length and potential physiological stresses. Responses may vary between species and varieties. Climate change will affect the timing of cereal crop development, but exact changes will also depend on changes in varieties as affected by plant breeding and variety choices. This study aimed to assess changes in timing of major phenological stages of cereal crops in Northern and Central Europe under climate change. Records on dates of sowing, flowering, and maturity of wheat, oats and maize were collected from field experiments conducted during the period 1985-2009. Data for spring wheat and spring oats covered latitudes from 46 to 64 degrees N, winter wheat from 46 to 61 degrees N, and maize from 47 to 58 degrees N. The number of observations (site-year-variety combinations) varied with phenological phase, but exceeded 2190, 227, 2076 and 1506 for winter wheat, spring wheat, spring oats and maize, respectively. The data were used to fit simple crop development models, assuming that the duration of the period until flowering depends on temperature and day length for wheat and oats, and on temperature for maize, and that the duration of the period from flowering to maturity in all species depends on temperature only. Species-specific base temperatures were used. Sowing date of spring cereals was estimated using a threshold temperature for the mean air temperature during 10 days prior to sowing. The mean estimated temperature thresholds for sowing were 6.1, 7.1 and 10.1 degrees C for oats, wheat and maize, respectively. For spring oats and wheat the temperature threshold increased with latitude. The effective temperature sums required for both flowering and maturity increased with increasing mean annual temperature of the location, indicating that varieties are well adapted to given conditions. The responses of wheat and oats were largest for the period from flowering to maturity. Changes in timing of cereal phenology by 2040 were assessed for two climate model projections according to the observed dependencies on temperature and day length. The results showed advancements of sowing date of spring cereals by 1-3 weeks depending on climate model and region within Europe. The changes were largest in Northern Europe. Timing of flowering and maturity were projected to advance by 1-3 weeks. The changes were largest for grain maize and smallest for winter wheat, and they were generally largest in the western and northern part of the domain. There were considerable differences in predicted timing of sowing, flowering and maturity between the two climate model projections applied.

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Climate Change and Human Health Literature Portal

Climate Scenario: M

specification of climate scenario (set of assumptions about future states related to climate)

Special Report on Emissions Scenarios (SRES)

Special Report on Emissions Scenarios (SRES) Scenario: SRES A1

Exposure: M

weather or climate related pathway by which climate change affects health

Food/Water Security

Food/Water Security: Agricultural Productivity

Geographic Feature: M

resource focuses on specific type of geography

None or Unspecified

Geographic Location: M

resource focuses on specific location

Non-United States

Non-United States: Europe

European Region/Country: European Region

Other European Region: Northern and Central Europe

Health Impact: M

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Mitigation/Adaptation: **☑**

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology: ™

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type: ™

format or standard characteristic of resource

Research Article

Timescale: M

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time period studied

Long-Term (>50 years)